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Some Nineteenth Century Indian Mathematicians Prior to Ramanujan*

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Abstract

This article highlights the contributions of some Indian Mathematicians who lived earlier than Ramanujan. For instance, we discuss the work of Radhanath Sikdar, who used sophisticated mathematics to identify for the first time the highest peak of Himalayas, of Ramachandra Lal, who solved problems of maxima and minima without the use of calculus, the work of the remarkable astronomer Samanta Chandra Sekhar, and the work of Ganesh Prasad, who apart from his work on potentials and theory of functions encouraged his junior colleague Bibhuti Bhushan Datta to write the monumental work '*History of Hindu Mathematics*' along with A.N. Singh.

Key words: De Morgan, Ganesh Prasad, Henry Derozio, Indian mathematicians of the 19th Century, Radhanath Sikdar, Ramachandra Lal, Ramanujan, Sagacity of the Bees, Samanta Chandrasekhar

1. Introduction

The aim of this article, as its title indicates, is to discuss lives and work of some Indian mathematicians of the nineteenth century, born prior to Ramanujan. In this context, let me first remark that under the vulpine initial incursions of the British and the disastrous battle of Plassey, India came under total British domination, which became much more pronounced and official after the formal take over of India by the British, during the middle of the nineteenth century. Let us remember that when one wishes to discuss the creative contributions of a civilisation (in particular to mathematics) during a certain period of time, an important parameter which plays a crucial role is the status of the civilisation at that time. For example, the Mayān civilisation, when it was at its peak, made remarkable contributions prior to the invasions of the Spanish, but there was nothing left of the civilisation to contribute, after these brutal attacks. Fortunately for India, however, in spite of successive foreign invasions, ending up with the subsequent complete British take over, India had the tenacity and did withstand the onslaughts, though in the process losing much of its ancient tradition, knowledge and lore, and mostly had to adapt itself to the English system of education. Let us note for instance that the great Srinivasa Ramanujan studied mathematics only through the English idiom and when the question of deciding where he could possibly go, to realise his great potential, it was England that he and his well-wishers chose as the best place and to England, indeed did he go! (Let us at the same time not forget the great support which Hardy gave to Ramanujan when the latter was in England, helping Ramanujan to channelize his talents).

* I dedicate this article with my warm affection to Professor R. Vijayaraghavan and to the fond and affectionate memory of his late wife Susila (It is indeed very hard for me even now to believe that she is no more). I knew them from my early years at the Tata Institute and they both have been pillars of support to me. Susila always brought to my mind the immortal lines "They also serve who only stand and wait" of Milton.

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The aim of this article is however, not to discuss the mathematical contributions of Ramanujan, but to sketch (though not delineate!) the work of some Indian mathematicians during the 19th century, who were prior to Ramanujan. More precisely, we shall discuss the work of Radhanath Sikdar, who identified for the first time the highest peak of the Himalayas by using sophisticated mathematical methods, of Ramachandra Lal, who was the first mathematician to discuss some problems of Maxima and Minima without the use of Calculus and of the remarkable astronomer Samanta Chandra Sekhar, (who until someone else showed him, was not even aware of the existence of a telescope!), who constructed and used his own instruments (like the '*Mana Yantra*') to observe celestial phenomena, correct the errors which had crept into the classical Indian texts on Astronomy, and to write his classic "*Siddhānta Darpaṇa*", in the tradition of the earlier *Siddhāntas*. (He has quite appropriately been christened by the international journal "*Nature*" in 1899 as a Modern Tycho Brahe!). We end with the contributions of Ganesh Prasad, who worked on the theory of potentials, theory of functions, worked with Hobson and Forsyth in England and spent a few years in Europe before coming back to India, where he contributed substantially to the growth of mathematics. A very important fact that should also be mentioned is that Ganesh Prasad inspired his junior colleague Bibhuti Bhushan Datta, when he was at the Calcutta University, which led Datta to write in collaboration with A. N. Singh a book titled "*History of Hindu Mathematics*", which has since been recognised as a classical piece of work on the subject. During our discussion of Sikdar, we discuss in passing the remarkable Anglo-Indian, Derozio, who was a very fine poet, a staunch Indian Nationalist, who had a great influence on Sikdar, and while discussing Ramachandra, we talk a little bit about the British mathematician Augustus De Morgan (son of an East India company official and who was born in Madurai, India) who helped Ramachandra immensely and also mention Charles Muses, who a few years ago wrote an interesting article in "*Math. Intelligencer*" (1998) on the work of Ramachandra pointing out that De Morgan really deserves the credit of "discovering" Ramachandra!

2. A few Remarks on Ramanujan

As we said at the beginning, we do not wish to discuss in this article either the life or the great mathematical contributions of Srinivasa Ramanujan. This has indeed been done several times before and quite thoroughly too, by many people (which include mathematicians and others) in various fora. However, it would only be proper on my part to do justice to this great man by making a few general remarks, since the day on which the lecture was given was 22nd December 2013 and Ramanujan was born on this date, in the year 1887. Among the many great men and women born in India of whom India is justly proud, and quite rightly cherishes their memory, Ramanujan occupies a premier place, in view of the not only the strangeness and novelty of his mathematics and of his methods which border on mystery, but added to this also, his the most unfortunate early death. We note the obvious fact that after all he specialised in mathematics and inspite of the fact that mathematics is indeed not the most favourite subject of interest to the "the common man", yet, he is remembered with reverence and awe by the uninitiated too! Several mathematicians of other countries too have the highest regard for him and his contributions and express their admiration (though at times through somewhat curious comparisons!) For instance, Emma Lehmer likened his "Lost Note Book" to a symphony of Beethoven! G.N. Watson said that a certain formula of Ramanujan gave him a thrill, which he felt when he entered the Medici Chapel and looked at the sculptures of Michaelangelo representing "Day", "Night", "Evening" and

"Dawn"! Bruce Berndt compares Ramanujan to Johann Sebastian Bach and gives a quote from Shelley's "*Hymn to Intellectual Beauty*". All these comparisons, though very complimentary, but yet certainly do not explain in any way the strange phenomenon of Ramanujan. Indeed, perhaps the best way to explain Ramanujan is to call him a *Svayam-bhu* (Self Born), as was done most appropriately by a writer in the "*Illustrated Weekly of India*" (who signs as R. G. K.) during the centenary of Ramanujan. Ramanujan really was a very rare and beautiful blossom, which India fortunately happened to have had on its soil. It is best to leave it at that*.

3. A Chronological List

Listed below are the names of mathematicians (the third one in the list is indeed an astronomer) of the nineteenth century whose lives and achievements we shall discuss in what follows.

Radhanath Sikdar (1813 -1870)
Ramachandra Lal (1821 -1880)
Samanta Chandra Sekhar (1835-1904)
Ganesh Prasad (1886 -1935)

4. Radhanath Sikdar

Radhanath Sikdar was the youngest child of Tituram and was born in Jorasanko in Calcutta. He was a follower of Henry Louis Vivian Derozio a reformer, about whom we will say a few words a little later. Radhanath Sikdar was a very brilliant student and took to Science as his life's main interest. In 1831, George Everest, the director of the "Great Trigonometric Survey" (GTS), was looking for a brilliant young mathematician with particular proficiency in Spherical Trigonometry. Radhanath, who was then studying at the "Hindu College" Calcutta was recommended very strongly by his mathematics teacher and Everest, based on his recommendation, appointed Radhanath as a "computer". Radhanath was first sent to Sironj near Dehradun to do geodetic survey, where he excelled as a surveyor. He used, apart from conventional techniques, a few new inventions of his own. Everest was extremely pleased with Sikdar's work, and indeed refused to let Sikdar leave his service at the GTS, when the latter was offered the job of a Deputy Collector! Everest retired in 1843 and Col. Waugh was appointed as the new Director. After twenty years of working in the North, Sikdar was transferred to Calcutta and was promoted as the Chief Computor. Apart from his duties at the GTS, Sikdar also served as a superintendent of the Meteorological Department. Here again Sikdar introduced several innovations which remained standard procedures for decades to come. Most notable amongst these was the formula for conversions of barometric readings taken at various temperatures to 32 degrees Fahrenheit.

At the order of Col. Waugh, he also started measuring the heights of the snow capped peaks near Darjeeling. He compiled data about peak XV from six different observations, which led eventually to his conclusion that this peak was the tallest in the world and he reported it to Col. Waugh. Waugh however wanted to be very cautious and insisted that the data be further checked. When after some years, he was convinced, he publicly announced the same. This peak is indeed the venerable Mount Everest!

Everest himself had followed the principle that when a new peak had to be named, a local name should be preferred. Waugh however went against it and as a tribute to Everest the peak was named after Everest! Sikdar was a very great favourite of both Everest and Waugh. But there were others in the organisation who were not favourably disposed towards him. One should remark for example that while the Survey Manual published in 1851 mentioned in its preface that

* I am indebted to Robert Kanigel's beautifully written book "*The Man who Knew Infinity*" (1991) for some of the sentiments expressed here.

the technical and mathematical chapters of the Manual were written entirely by Sikdar, (and this Manual was put to immense use by the surveyors), its third edition, published in 1875 (after the death of Sikdar), did not contain this preface at all! There were also other instances to show that Sikdar was not treated with respect, which he certainly was entitled to. Incidentally, it must be mentioned that Sikdar was very much influenced by Derozio about whom we mentioned earlier and Sikdar and his Derozian friend P. C. Mitra published the Bengali journal "*Masik Patrika*" devoted to the education and empowerment of women. After his retirement from GTS. in 1862, Sikdar worked as a mathematics teacher at the Scottish Law College.

It is perhaps not inappropriate at this stage to mention a few things about Derozio, who had a great in influence on Sikdar.

4.1 Henry Louis Vivian Derozio (1809 -1831)

Henry Louis Vivian Derozio (1809 - 1831) was a very well respected man who was an Anglo-Indian and of Portuguese origin. He attended school from the age of 8 till 14. After quitting the school, he joined his father's concern. At the early of age of seventeen, he was regarded by many as a great scholar. Very much like Raja Ram Mohan Roy, he started a movement aiming at Indian renaissance. Derozio joined the Hindu College as a teacher of English. He was a free thinker and led an intellectual movement in Bengal called the "Young Bengal movement". (Sikdar was an active member of this movement). Though Anglo-Indian by birth, he was a very staunch Indian nationalist. Derozio was a very fine poet too. He wanted India to become a great nation and I include a poem of his lamenting on the state of India at his time.

To India, My Native Land
My country! In the days of Glory Past
A beauteous halo circled round thy brow
And worshipped as deity thou wast
Where is that Glory, where is the reverence now?
The eagle pinion is chained down at last,
And grovelling in the lowly dust art thou
Thy minstrel hath no wreath to weave for thee
Save the sad story of thy misery.

5. Ramachandra Lal

Ramachandra Lal was born in 1821 at Panipat (which is about fifty miles away from Delhi), when Delhi was under the British rule. There was of course a Mughal Emperor on the throne, but he was virtually under the East India Company. Ramachandra was born in a middle class Kayastha family, his father being an employee of the East India Company. He died when Ramachandra was only nine years old. He was brought up by his mother and the family faced innumerable economic hardships. After some private education, Ramachandra entered an English Government school in Delhi and had a small scholarship. Ramachandra was married to a very young girl with disability, who was the daughter of a rich man. Inspite of all his personal problems, Ramachandra seems to have set for himself high academic standards in mathematics and it appears that he educated himself in mathematics by self-study and did not benefit much by his school education. In 1843, Ramachandra was appointed as a Science Teacher at Delhi College and at that time, his career as a journalist translating English books into Urdu seems to have started. He appears to have been very much impressed by the advancement of Science in West and it is noteworthy that he read books on mathematics, mostly in Algebra by the British authors (e.g: Wood's "Algebra") though at the same time he seems to have been familiar with classical Indian treatises like Bhāskara's "*Bījagaṇita*" and "*Līlāvatī*". He in fact wrote a book in Urdu based on the latter works! One could even perhaps say that he was trying to get a cultural synthesis between the Indian and the Western (British) way of mathematical thinking. A typical and crucial example to illustrate this is his book titled "*A treatise on the Problems of Maxima and Minima* (solved by Algebra)", first published in

Delhi in 1850. Ramachandra's aim in this book was to solve certain interesting problems of finding maxima and minima, avoiding calculus, using algebraic methods instead. His methods could be used in solving problems in maxima and minima which eventually deal with polynomials of degrees 2, 3 and sometimes 4, in one (and sometimes in several variables). This book was published by him in 1850, when he was only twenty-nine years old! The book did create a certain amount of stir among the academics, but however got some critical reviews; for instance in "*Calcutta Review*". Ramachandra was very disturbed by the treatment that his book received from some of the academic circles and wrote a rejoinder to the journal. He then approached J. E. Drinkwater Bethune, who was the then Chairman of the Education Commission in Calcutta and who was a very in influential Government official and gave him some copies of his book, requesting him to send them to mathematicians in England for their assessment of the book. J. Drinkwater Bethune who was a very kind man and who believed in encouraging Indians, sent a copy of Ramachandra's book to his friend Augustus De Morgan (about whom we will discuss a bit a little later), who was at that time a Professor of Mathematics at the University College, London. We should remark that among the British administrators in India favourably disposed to India, John Drinkwater Bethune's name is certainly a prominent one! (Incidentally, he died prematurely, a year or so after he sent Ramachandra's book to De Morgan).

5.1 Augustus De Morgan (1806 -1871)

De Morgan who founded the London Mathematical Society and was its first President, was born in Madurai, South India, as the son of an employee of the East India Company. Unfortunately, he lost his vision in one of his eyes, even as a child. De Morgan went back to England and his education was in England. He entered Trinity in February 1823 and graduated in 1827. He was a man with very strict codes of conduct and a free thinker. On a matter of principle, he did not go in for his Master's degree. He was however made a professor by his merit in the then newly formed London University. He was very well versed in Algebra, Set theory and Logic. His famous laws which give the complement of the union of two sets as the intersection of the complements and dually the complement of the intersection of two sets as union of the complements, are well known as De Morgan's laws!

He was a very close friend of W. R. Hamilton, who was acclaimed among other things for his discovery of quaternions.

Coming back to our narrative of Ramachandra's book being sent to De Morgan, indeed, De Morgan was very impressed by Ramachandra's work, corrected some slips and republished the book in 1859 with a very lengthy introduction, praising Ramachandra and sent this revised version to many mathematicians of Europe. In his introduction, which is quite long, De Morgan, discussing the mathematical heritage of Ancient India in connection with Ramachandra's book, remarks that the ancient Indian mathematicians were very proficient though in Algebra (He was obviously familiar with the work of Brahmagupta and Bhāskara through Colebrooke's famous English translations), yet their Analysis was not advanced. The great work of the Kerala mathematicians from the fourteenth to the eighteenth century, which was discovered by Charles M. Whish (who was an employee of the East India Company) and who published a remarkable paper in "*The Transactions of Royal Society of Great Britain and Ireland*" in 1835 titled "On the Indian Quadrature of the circle and the infinite series for the proportion of the circle to the diameter exhibited" was not apparently known to De Morgan!

In this connection a book titled "*Problems of Maxima and Minima,* solved by Algebra, by Ramachandra" published by *The Association of Mathematics Teachers of India* in 2007 may be mentioned. It is reedited by Dr. M. S. Rangachari, based on the 1859 edition of the book mentioned above. In fact Professor Rangachari, as he says in the "Editor's Introduction", got a copy of De Morgan's edition from one Mr. C. A. Reddi, a close friend of his. He also mentions in this Introduction, about the apparent ignorance of De Morgan of the Kerala mathematicians and of a very interesting article titled "De Morgan's Ramanujan, An Incident in Recovering Our Endangered Cultural Memory of Mathematics", written by C. Muses, in the *Math. Intelligencer* [20, (1998), vol.3, p.47-51] and says that "Mr. Reddi brought Muses" article to his notice as well as providing a copy of De Morgan's edition of Ramachandra's work, which made him undertake to write his book. Rangachari's introduction also gave me a pleasant surprise, when he mentions that Ramachandra's life and work had already been discussed in the July, 1929 volume of "*Indian Scientists*", published by one of the well known and venerable South Indian publishers "G. A. Natesan & Co".

5.2 Ramachandra's Attitude to the West

We wish to add a short sketch of Ramachandra's attitude to religion and towards the British. He had been always claiming that he had no religious bias and had read Hindu Scriptures, *The Koran* etc. He had also said to those whom he knew that he did not like the idea of being converted, when some Indians began suspecting that he was getting attracted to the British ways and that he might eventually get himself converted to Christianity. However, he did eventually convert himself to Christian faith and got himself baptized! Of course, obviously the Christian missionaries played their usual role in looking out for natives to convert! It is perhaps a valid conjecture that when Ramachandra got no support for his work from Indian academia, Bethune rendered him enormous help by sending his work to De Morgan who took trouble to republish his book and give it publicity among the mathematicians of the West. Also, Ramachandra got substantial financial support from the British after the worth of his work was recognised. There is nothing surprising about his feeling indebted to the British. In fact some Indians were convinced that he was very pro-British and accused him for not writing his book in his native language Urdu, but chose English, a foreign tongue. This in fact resulted in Ramachandra being hated during the Indian Mutiny and he was hunted by some mutineers. However, he was given protection by an Indian Zamindar, saving his life.

I would like to end this section on Ramachandra with a proof of his algebraic solution to a problem related to one on the honeycomb (which dates back to antiquity essentially to show that the bees choose the shape of honeycombs where they store their honey, in such a manner that they use minimum amount of wax to maximize the volume). This problem occurs as Problem 52 in the volume published by De Morgan and is referred to in detail by Muses in his paper mentioned above.

5.3 The Efficiency of the Bees and a Problem considered by Ramachandra

The Greeks were fascinated by the "sagacity" of the bees. Sir Thomas Heath in Vol II of his classical book, "*A History of Greek Mathematics*" (republished by Dover publication, New York, 1981), while discussing the work of the Greek geometer Pappus (third century AD), mentions that Pappus in his famous "Synagoge" (which means "Collection" in Greek), which is a compendium of the accumulated geometrical accomplishments of the Greeks, in Book V, has written a beautiful preface on the "Sagacity of the Bees", which is an outstanding example of Greek excellence in literary style of writing. I quote partly

from Heath's English translation: 'Pappus begins with'

> "It is of course to men that God has given the best and most perfect notion of wisdom in general and of Mathematical Science in particular, but a partial share in these things, he allotted to some of the unreasoning animals as well. To men, as being endowed with reason, he vouchsafed that they should do everything in the light of reason and demonstration, but to the other animals, while denying them reason he granted that each of them shall, by virtue of some natural instinct, obtain just so much as is needful to support life. This instinct may be observed to exist in very many other species of living creatures, but most of all in bees..... ."

We also include an interesting remark of the very great mathematician, Hermann Weyl, on the wisdom of the bees. In his beautiful book which is based on his lectures and is titled "Symmetry", he puts the following words in the mouth of the Bee!

> "My house" says the bee in the 'Arabian Nights' "is constructed according to the most severe architecture. Euclid himself could learn from studying the geometry of my cells... ."

Ramachandra considered a mathematical version of the above in the following:

5.4 Problem

A regular hexagonal prism is regularly terminated by a trihedral solid angle formed by planes, each passing through two angles of the prism. Find the inclination of these planes to the axis of the prism, in order that, for a given content, the total surface may be the least possible (p.75, Chapter II of the book edited by De Morgan).

Proof. Let ABCabc be the base of the prism and PQRS, one of the faces of the terminating solid angle passing through P, R. Let S denote the vertex of the pyramid and SO perpendicular to the upper surface of the prism. Let OM, RP, SQ intersect each other in *N*. It is easy to see that MN = NO and hence SO = QM. The triangle POR and PMR being congruent, whatever be the inclination of SQ to ON, the part cutoff from them is equal to the part included in the pyramid SPR and the volume of the whole therefore remains constant.

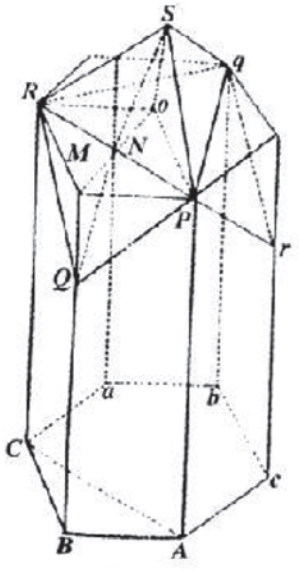

Fig. 1. The truncated hexagonal prism

We now determine ∠ONS or ∠OSN, so that the total area of the surface should be minimum. Let AB = *a*; PA (the height of the prism) = *b* and ∠OSN = θ. We have ON = MN = $\frac{a}{2}$, and SN = $\frac{a}{2}\operatorname{cosec}\theta$, QM = $\frac{a}{2}\cot\theta$. Then the area of APBQ = $\frac{a}{2}(2b - \frac{a}{2}\cot\theta)$.

The area of PQRS = PR× SN = $\sqrt[3]{\frac{a^2}{2}}\operatorname{Cosec}\theta$,

so that the total area of the solid is $3a\left(2b - \frac{a}{2}cot\theta\right) + \frac{\sqrt{3}a^2}{2}cosec\theta = 6ab + \frac{3a^2}{2}\left(\sqrt{3}cosec\theta - \cot\theta\right)$.

This should be a minimum so that $\sqrt{3}\operatorname{cosec}\theta - \cot\theta$ should be minimum, which we call *r* and let $x = cot\theta$. Hence $cosec\theta = \sqrt{1+x^2}$ so that $\sqrt{3+3x^2} - x = r$ and we have the quadratic equation

$$x^2 - rx = \frac{r^2 - 3}{2}.$$

The discriminant of this equation is $3r^2 - 6$, so that the minimum of r must be equal to $\sqrt{2}$ and $x = \frac{r}{2} = \frac{1}{\sqrt{2}}$, so that $cot\theta = x = 1/\sqrt{2}$ and $\tan\theta = \sqrt{2}$ and hence θ is approximately $54°44'8.2''$ and $\pi - 2\theta = \sec^{-1}\theta$, which is roughly $70°32'$.

Ramachandra adds after the above solution of his problem the following remarks:

> "This is the celebrated problem of the form of the cells of bees. Maraldi was the first who measured the angles of the faces of the terminating solid angle and he found them to be 109°28′ and 70° 32′ respectively. It occurred to Reaumur that this might be the form, which, for the same solid content, gives the minimum of surface, and he requested König to examine the question mathematically. That geometer confirrmed the conjecture; the result of his calculation agreeing with Maraldi's measurements within 2′. Maclaurin and S. Huiller, by different methods, verified the preceding result, excepting that they showed that the difference of 2′ was owing to an error in the calculation of König, and not to a mistake on the part of the bees".

6. Samanta Chandra Sekhar

The Siddhāntic tradition of Astronomy in India, which began in the Vedic period includes *Sūrya-siddhānta*, *Vyāsa-siddhānta* and others, and followed by many classical Astronomical works later like those of Āryabhaṭa, Brahmagupta and Bhāskara (and finally that of the Kerala School of Astronomy, spearheaded by the great Mādhava, Nīlakaṇṭha Somayaji). Thus the Siddhāntic system has had a very long history. It is a matter of pride for India that in this long chain of astronomical works, Samanta Chandra Sekhar (1835-1904) of Orissa belongs and that he wrote his great work "*Siddhānta Darpaṇa*", which incorporated corrections to some of the errors which had crept in the earlier *Siddhāntas* and by painstaking, life-long observations of celestial bodies and phenomena without even knowing (not to talk of using) instruments like the telescope (the use of which has been known to the West since the seventeenth century). That the International Journal, *Nature*, compared Tycho Brahe to Samanta Chandra Sekhar is indeed an honour very well deserved! Samanta Chandra Sekhar was born on 13th December in the year 1835, in the Royal family in Khandpara, one of the then existing states of Orissa, which was enjoying some degree of autonomy under the British rule. (Khandpara is about sixty miles west of Bhuvaneshwar). The kingdom during the time of Samanta Chandrasekhar was ruled by his nephew who turned jealous of him and put obstacles in his way. But Samanta on the other hand with magnanimity, pleaded with the British commissioner at Cuttack for mercy for the king, when the commissioner wanted to issue an arrest warrant to the king on one occasion when the King had tried to prevent by devious methods, Samanta from receiving the title of "*Mahāmohapadhyāya*" from the British.

Samanta since his childhood had been interested in locating heavenly objects and once he spotted the Venus in the sky during the day when he was yet a child. The father thought it was an ill omen for the child and performed an *Yajña* before Lord Jagannath of Puri to get rid of the sin. Samanta's interests in gazing at the heavens continued all his life and on the other hand he became at the same time proficient in Sanskrit and read all the classical texts including texts on grammar and all the important mathematical and astronomical works like *Sūrya-siddhāntha*, *Siddhāntha Śiromaṇi* and others. At the very early age of 15, he began to check the predictions of the *Siddhāntas* against his observations and found discrepancies. He constructed his own instruments for his observations and one of his most well known instruments is "*Mana Yantra*". After making diligent and untiring observations he

decided to write his famous work "*Siddhānta Darpaṇa*", a work which he completed in 1869.

Professor Jogesh Chandra Ray played a crucial role in the publication of this work, which was originally written in the classical Indian manner on palm leaves in Sanskrit language in Oriyan script which was converted into Devanagari script in a Calcutta press in 1899. Among many other things for which Samanta can be admired, a very important one is that when the old *Pancāṅga* of the Puri temple was known to be inaccurate and a new one had to be adopted, after much deliberations and tests, it was found that the readings of the "*Siddhānta Darpaṇa"* were more accurate and a new *Pancāṅga* based on his readings was adapted, a real honour for Samanta. Finally, one must note that in spite of erudition in classical Indian wisdom, Samanta was a very gentle person and led a very simple and pious life and indeed went through a lot of physical pain and physical suffering. Truly, he was out and out a great Indian genius, who was not influenced in any manner by Western thought and ideas.

7. Ganesh Prasad

Ganesh Prasad (1876 -1935) was born at Balia, Uttar Pradesh. He studied in Allahabad, got his Master's and D.Sc. degrees from Allahabad University. After teaching at Allahabad for about two years, he went to the University of Cambridge, England, where he worked with E. W. Hobson, and A. Forsyth. He competed for the Adam's prize, but was unsuccessful. Later on, he moved to Europe and in particular to Göttingen, where he was associated with mathematicians there like D. Hilbert, G. Cantor and A. Sommerfeld. In Göttingen, Ganesh Prasad showed his paper titled "On the constitution of matter and the analytic theories of heat", the one he had submitted earlier for Adam's prize, to Felix Klein, who liked the results and got the paper published in "*Göttingen Abhandlungen*". After spending five years abroad, Ganesh Prasad returned to India and was appointed as a professor at Central College, Allahabad. He was then at the Queen's College at Banaras till 1914 and thereafter was the Head of the Department of Mathematics of the Calcutta University. He indeed occupied several posts as a Professor at the Calcutta University till his death in 1935. During this time, he also went to Banaras to work at the Banaras Hindu University, and while at Banaras, he initiated the establishment of "Banaras Mathematical Society". He became the President of the Calcutta Mathematical Society. It is interesting to note that he was also a founder member of the "National Institute of Sciences" which has been rechristened later as the "The Indian National Science Academy".

His two volume work, "*Some Great Mathematicians of the Nineteenth Century*" published in 1933, is regarded as a landmark publication. I would end my discussion of the contributions of Ganesh Prasad by mentioning the most important fact that he encouraged Bibhuti Bhushan Datta, a junior colleague of his at the Calcutta University to undertake the painstaking investigations in the history of Indian Mathematics, which led eventually to the classical and monumental "*History of Hindu Mathematics*" in two volumes written by Datta in collaboration with A. N. Singh.

8. Concluding Remarks

In this article, I have discussed a few mathematicians about some of whom, I became aware only a few months ago! It is of course possible that I still have missed out some significant mathematicians. I own that this might be due entirely to the lack of my knowledge. In any case, I feel happy that the nineteenth century, which was a period of unrest and unsettled conditions in India, did produce some good Indian mathematicians, apart from the great Ramanujan!

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